# uFR Desfire® example C console
# Version 1.7.



Digital Logic Ltd.

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# Table of contents





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# 1. Application overview

Link: https://git.d-logic.net/nfc-rfid-reader-sdk/ufr-ds-examples-c.git

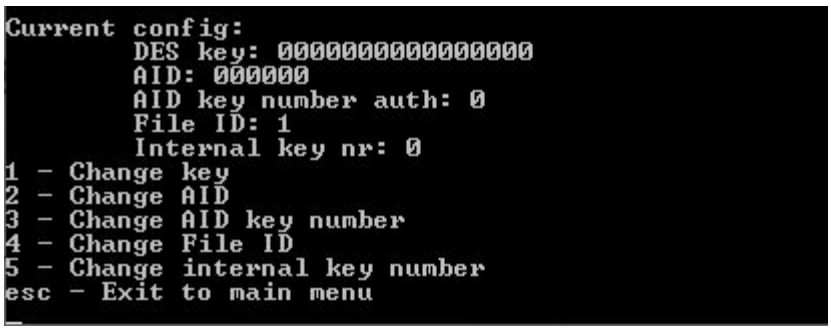
When you start application, it looks like this:

Key for authentication, AID, AID key number for authentication, File ID and internal key index are read out from config.txt file.

## 1.1. Config file explanation (config.txt)

Configuration file config.txt is loaded when the application starts. There are key for authentication, AID, ordinal number of keys in AID for authentication, File ID and internal key index (when key stored into reader).
File structure:
DES key: 0000000000000000
AID 3 bytes hex: 000000
AID key number for auth: 0
File ID: 1
Internal key number: 0
First line contains the key type, and hexadecimal value of the key.
If key type is DES (8 bytes) then 16 characters must be entered (DES key: 0102030405060708)
If key type is 2K3DES (16 bytes) then 32 characters must be entered (2K3DES key: 01020304050607080910111213141516)
If key type is 3K3DES (24 bytes) then 48 characters must be entered (3K3DES key: 010203040506070809101112131415161718192021222324)
If key type is AES (16 bytes) then 32 characters must be entered (AES key: 01020304050607080910111213141516)
Second line contains AID, 6 characters must be entered (AID 3 bytes hex: 010203)
Third line contains ordinal number in application for authentication (0 to maximal number of application keys - 1)
Fourth line contains the index of the File ID in application. If the function doesn't use this parameter, then this value will be ignored.
Fifth line contains the ordinal number of the key for authentication stored into the reader.

Configuration file can be changed from application when ‘t’ pressed (Change config parameters).
First, you will see the current config.txt file with options 1 - 5 for changing and esc for back to main menu.




For key changing press ‘1’. There are four types of key for authentication.

```
Enter key type
1 - DES (8 bytes)
2 - 2K3DES (16 bytes)
3 - 3K3DES (24 bytes)
4 - AES (16 bytes)
```

For example press '3' for 3K3DES key. Enter 24 bytes in hexadecimal format (48 characters).

```
Input new 3K3DES key (24 bytes):
010203040506070809101112131415161718192021222324
1 - Change key
2 - Change AID
3 - Change AID key number
4 - Change File ID
5 - Change internal key number
esc - Exit to main menu
```

When the change is over, press the ESC button for return in the main menu, and then press 't' for modification checking.

```
Current config:
        3K3DES key: 010203040506070809101112131415161718192021222324
        AID: 000000
        AID key number auth: 0
        File ID: 1
        Internal key nr: 0
1 - Change key
2 - Change AID
3 - Change AID key number
4 - Change File ID
5 - Change internal key number
esc - Exit to main menu
```

The type and value of authentication key is changed.

## 1.2. Change authentication mode (0)

There are 3 modes of authentication.
SAM key authentication mode available only for uFR Classic CS with SAM and firmware versions 5.100.x.
For firmware versions 5.100.x using internal and provided keys is restricted to AES keys only. DES, 2K3DES and 3K3DES keys can be used with SAM only. AES key may be used in all authentication modes.
With regular firmware versions 5.0.x from 5.0.25 all key types may be used. uFR Classic CS with SAM works with firmware versions 5.0.x too.

```
Select authentication mode:
 (1) - Internal key
 (2) - Provided key
 (3) - SAM key
3
 Authentication mode is set to SAM KEY
```

## 1.3. Master key authentication (1)

For switching between master key authentication, press '1' on the keyboard.
It looks like this (here is '1' pressed twice):



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```
Master key authentication is not required
Master key authentication is now required
```

Whether authentication is required or not, depends on the master key of the card or application settings.

## 1.4. Get card UID (2)

For card UID (7 bytes) press ‘2’. Valid authentication with master or application key is required.

```
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 167 ms
CARD UID = 04658E42EC3580
```

## 1.5. Format card (3)

Pressing number '3' on your keyboard will cause a formatting card (deleting all applications and files except AID with number: 000000). Depending on which authentication mode you chose, it will look for the AES key into the reader (INTERNAL KEY) or in config.txt file (PROVIDED KEY).

```
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 574 ms
Card is formatted
```

## 1.6. DES to AES (4)

Changing the card master key from factory DES key 0x0000000000000000 to AES key 0x00000000000000000000000000000000.

## 1.7. AES to DES (5)

Changing the card master key from AES key 0x00000000000000000000000000000000 to DES key 0x0000000000000000.



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## 1.8. Get free memory (6)

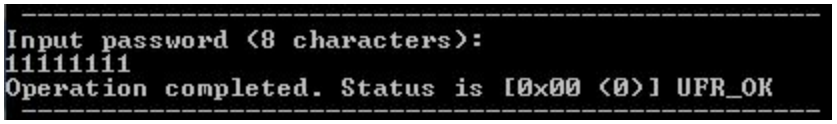
Read the quantity of available memory on the card.


## 1.9. Set random ID (7)

Activating the random ID card options by Set Random ID button. Required authentication using card master key.
The card returns 4 bytes random ID instead 7 bytes unique ID.
Warning: this operation is irreversible.
When this option is activated, the UID can be read by a special command that requires authentication using a valid key.

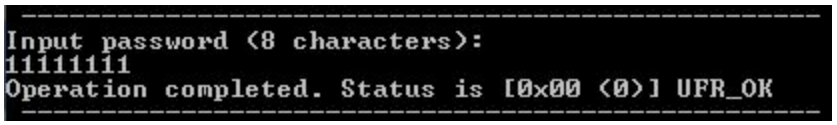
## 1.10. Internal key lock (8)

You have to enter a password (8 characters length) to lock keys enrollment. Factory password is "11111111".




## 1.11. Internal key unlock (9)

To unlock the possibility to enroll keys into the reader, you must enter the same password to unlock keys which is entered to lock keys enrollment. Factory password is "11111111"




## 1.12. Set baud rate (a)

After activating the option 'Set baud rate' by pressing 'a' on the keyboard you will see multiple choices to choose for transceive and receive baud rate. Just enter the number next to the option you want to choose.

```
Enter value for setting transmit rate (tx speed)
0 - 106 kbps
1 - 212 kbps
2 - 424 kbps
0
Enter value for setting receive rate (rx speed)
0 - 106 kbps
1 - 212 kbps
2 - 424 kbps
0
Operation completed. Status is: [0x00 (0)] UFR_OK
```

## 1.13. Get baud rate (b)

Read values of transmit and receive baud rate of reader.

```
TX baud rate = 106 kbps;
RX baud rate = 106 kbps;
```

## 1.14. Store key (or Reader ID for Transaction MAC) into reader (c)

First choose the type of key.

```
Enter key type
1 - DES (8 bytes)
2 - 2K3DES (16 bytes)
3 - 3K3DES (24 bytes)
4 - AES (16 bytes)
5 - Reader ID (transaction MAC)
```

For example, choose the 3K3DES key. Key 0x0102030405060708091011121314151617181920212222324.
Internal key index is 0. For 3K3DES keys two key fields into the reader will be occupied. In this case 0 and 1. First free key index is 2. For other key types just one key field will be used.

```
Enter key type
1 - DES (8 bytes)
2 - 2K3DES (16 bytes)
3 - 3K3DES (24 bytes)
4 - AES (16 bytes)
3
Two key fields will be occupied !!!
Enter 3K3DES key (24 bytes):
0102030405060708091011121314151617181920212222324
Input reader internal key number (0-15):
0
Operation completed. Status is [0x00 (0)] UFR_OK
```

Reader ID for the transaction MAC is a 16 bytes array.



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## 1.15. Change key (d)

Changing card master, and application master and user keys. When changing master key, then may be change the key type and value of key. In application all keys are the same type, and the key type doesn't change.
For example, change master key to 3K3DES type, and value 0x0102030405060708091011121314151617181920212222324.

```
 ------------------------------------------------
MASTER KEY CHANGE !!!
 Enter new key type
 1 - DES (8 bytes)
 2 - 2K3DES (16 bytes)
 3 - 3K3DES (24 bytes)
 4 - AES (16 bytes)
3
Input new 3K3DES key (24 bytes):
0102030405060708091011121314151617181920212222324
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 100 ms
 ------------------------------------------------
```

## 1.16. Change key setting (e)

For changing key settings, carefully read available settings and choose one. Take care about the setting you chose, some of them cannot be changeable anymore. If you are changing settings for AID 000000 - IT CAN'T BE FORMATTED.

```
------------------------------------------------
Choose key settings:
0 - No settings
1 - Settings not changeable anymore
2 - Create or delete application with master key authentication
3 - Master key not changeable anymore
4 - Settings not changeable anymore and create or delete application with master key
5 - Settings and master key not changeable anymore
6 - Create and delete application with master key and master key is not changeable anymore
7 - Settings not changeable anymore, create or delete application with master key, master key is not changeable anymore
```

## 1.17. Get key setting (f)

Read card master or application master key settings and maximal number of application keys. For example read card master key settings.

```
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 160 ms
Maximal number of keys into application: 1
2 - Create or delete application with master key authentication
```

## 1.18. Make application (g)

For example make application with AES keys. AID = 0xA10000. Maximal key number 3.

```
 Choose application key type:
 1 - DES
 2 - 3K3DES
 3 - AES
3
Input  AID tnumber (3 bytes hex): A10000

Input maximal key number: (1 - 14)3
 Choose application master key settings:
 0 - No settings
 1 - Settings not changeable anymore
 2 - Create or delete file with master key authentication
 3 - Master key not changeable anymore
 4 - Settings not changeable anymore and create or delete file with master key
 5 - Settings and master key not changeable anymore
 6 - Create and delete file with master key and master key is not changeable anymore
 7 - Settings not changeable anymore, create or delete file with master key, master key is not changeable anymore

2
=============
OK
Execution time of operation = 196 ms

Application created
```



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## 1.19. Delete application (h)

Enter AID to delete.

```
Input AID to delete (3 bytes hex): A10000
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 184 ms
```

## 1.20. Make file (j)

In the configuration file set the AID and application master key.
For example make Standard Data File, size 100 bytes, enciphered communication.

```
Input File ID: 1
Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Choose file type:
 1 - Standard data file
 2 - Value file
 3 - Linear record file
 4 - Cyclic record file
1
Enter Read key number: 0
Enter Write key number: 0
Enter Read/Write key number: 0
Enter Change key number: 0
Enter size of the file you wish to create: 100
=============
OK
Execution time of operation = 90 ms


File created
```

Example: Make value file. Lower limit is 0, upper limit is 200, initial value is 100. Enciphered communication mode.



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```
Input File ID: 2
Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Choose file type:
 1 - Standard data file
 2 - Value file
 3 - Linear record file
 4 - Cyclic record file
2
Enter Read key number: 0
Enter Write key number: 0
Enter Read/Write key number: 0
Enter Change key number: 0
Enter lower limit of your Value file: 0
Enter upper limit of your Value file: 200
Enter value of your Value file: 100
Do you wish to enable Limited credit?
 1 - Yes
 2 - No
2
Do you wish to enable Free get value?
 1 - Yes
 2 - No
2
=============
OK
Execution time of operation = 84 ms


File created
```

Example: Make a linear record file. Size of record is 100, maximal number of records is 3, enciphered communication mode.

```
Input File ID: 3
Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Choose file type:
 1 - Standard data file
 2 - Value file
 3 - Linear record file
 4 - Cyclic record file
3
Enter Read key number: 0
Enter Write key number: 0
Enter Read/Write key number: 0
Enter Change key number: 0
Enter size of record: 100
Enter maximal number of records: 3
=============
OK
Execution time of operation = 100 ms


File created
```

Example: Make Transaction MAC file at Desfire Light card. Transaction MAC key is 0x00112233445566778899AABBCCDDEEFF. Commit Reader ID key number is 1.



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```
 ------------------------------------------------
Input File ID: 15
Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
1
Choose file type:
 1 - Standard data file
 2 - Value file
 3 - Linear record file
 4 - Cyclic record file
 5 - Transaction MAC file (Desfire Light and Desfire EV2 only)
5
Enter Read key number: 0
Enter Commit Reader ID key number: 1
Enter Change key number: 0
Input transaction MAC AES key (16 bytes):
00112233445566778899AABBCCDDEEFF
=============
OK
Execution time of operation = 123 ms


File created
 ------------------------------------------------
```

## 1.21. Delete file (k)

In the configuration file set the AID, and application master key. Enter File ID for deleting.

```
 ------------------------------------------------
Enter file ID to delete:
1
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 83 ms
 ------------------------------------------------
```

## 1.22. Write Std file or Record (l)

In configuration file set the AID,  application key for Write or Read&Write access, and File ID.
For example write text to Standard data file, enciphered communication mode. Text read from file write.txt.
Size of text must be less or equal to size of file.



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```
------------------------------------------------

Choose file type:
 1 - Standard data file
 2 - Record file
1

Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 82 ms
------------------------------------------------
```

Example: Write record file.

```
------------------------------------------------

Choose file type:
 1 - Standard data file
 2 - Record file
2

Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 114 ms
------------------------------------------------
```

Example: Write record with Transaction MAC

```
Choose file type:
 1 - Standard data file
 2 - Record file
2

Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3

Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Transaction MAC is not used
1 - Transaction MAC is used
1

Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Reader ID is not used
1 - Reader ID is used
1
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 162 ms
Writing is successful

Transaction MAC counter = 4
Reader ID = 01020304050607080910111213141516
Previous encrypted Reader ID = 96414B97802C84E410A2FAAE1CB45720
Transaction MAC = B5D72062048FA258
Input transaction MAC AES key (16 bytes):
00112233445566778899AABBCCDDEEFF

Enter card type:
1 - Desfire EV2
2 - Desfire Light
2

Transaction MAC is correct
Previous Reader ID = 01020304050607080910111213141516
```



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## 1.23. Read Std file or Records (m)

In the configuration file set the AID, application master key, and File ID.
For example read data from Standard data file, enciphered communication mode. Readed data will be saved into read.txt file.

```
Choose file type:
 1 - Standard data file
 2 - Record file
1
Input file length to read: 100

Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 126 ms
```

Example: Read two records.

```
Choose file type:
 1 - Standard data file
 2 - Record file
2
Enter record size: 100
Enter number of records: 2

Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 149 ms
```

## 1.24. Read value file (n)

In the configuration file set authentication key, AID, AID key number for reading, and File ID.

```
Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 61 ms
Value: 100
```



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## 1.25. Increase value file (o)

In the configuration file set authentication key, AID, AID key number for Read&Write access, and File ID.
Example: Increase value file by 20.


Example: Increase value file by 50. Use Transaction MAC and Reader ID. Transaction MAC key is 0x00112233445566778899AABBCCDDEEFF.



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```
 ------------------------------------------------

Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3

Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Transaction MAC is not used
1 - Transaction MAC is used
1

Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Reader ID is not used
1 - Reader ID is used
1

Value for increasing:
50
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 149 ms
Value increased by: 50

Transaction MAC counter = 2
Reader ID = 0102030405060708091011121314 1516
Previous encrypted Reader ID = 7AB157B64831AEEE6DDFD1DCE75CA563
Transaction MAC = 00A7F88D92430C8C
Input transaction MAC AES key (16 bytes):
00112233445566778899AABBCCDDEEFF

Transaction MAC is correct
Previous Reader ID = 0102030405060708091011121314 1516
 ------------------------------------------------
```

## 1.26. Decrease value file (p)

In the configuration file set authentication key, AID, AID key number for Read, Write or Read&Write access, and File ID.
Example: Decrease value file by 20.



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Example: Increase value file by 50. Use Transaction MAC and Reader ID. Transaction MAC key is 0x00112233445566778899AABBCCDDEEFF.

```
 ------------------------------------------------

Choose communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
3

Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Transaction MAC is not used
1 - Transaction MAC is used
1

Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Reader ID is not used
1 - Reader ID is used
1

Value for decreasing:
50
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 149 ms
Value decreased by: 50

Transaction MAC counter = 3
Reader ID = 01020304050607080910111213141516
Previous encrypted Reader ID = 3236BB74FCD95F64207BFD1424F61B63
Transaction MAC = 904612E5F0389BE6
Input transaction MAC AES key (16 bytes):
00112233445566778899AABBCCDDEEFF

Transaction MAC is correct
Previous Reader ID = 01020304050607080910111213141516
 ------------------------------------------------
```

## 1.27. Clear record file (q)

In the configuration file set authentication key, AID, AID key number for Read&Write access, and File ID. All records in the Linear or Cyclic Record file will be deleted.



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```
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 85 ms
All records deleted
```

Example: Clear record file with Transaction MAC

```
Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Transaction MAC is not used
1 - Transaction MAC is used
1

Desfire Light and Desfire EV2 only
For other cards enter 0
0 - Reader ID is not used
1 - Reader ID is used
1
Operation completed
Function status is: [0x00 (0)] UFR_OK
Card status is: CARD_OPERATION_OK
Execution time: 138 ms
All records deleted

Transaction MAC counter = 5
Reader ID = 0102030405060708091011121314151 6
Previous encrypted Reader ID = 19430ED1F0629F2614487A020F4A5C10
Transaction MAC = CEB2F4FF84CBD247
Input transaction MAC AES key (16 bytes):
00112233445566778899AABBCCDDEEFF

Transaction MAC is correct
Previous Reader ID = 0102030405060708091011121314151 6
```

## 1.28. Get Application AIDs (r)

In the configuration file set card master authentication key, AID = 0x000000.

```
Found 3 application IDs:
A10000
D10000
D30000
Execution time: 162 ms
```



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## 1.29. Store key into SAM (s)

First select the card key type, and enter the value of key and ordinal key number into SAM from 1 to 127 (if the user has access right for this key). Then enter host authentication key ordinal number, version of host authentication key, and value of AES authentication key.

For example enter 3K3DES key 0102030405060708090A0B0C0D0E0F101112131415161718 into SAM key number 125 with SAM host authentication with AES host key 11111111111111111111111111111111, key number 126 and key version 10.


## 1.30. Get file settings (u) (DESFIRE LIGHT only)

Read file settings.



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```
Enter file number:
0

Standard data file
Plain communication mode
Read key no = 2
Write key no = 3
Read/Write key no = 3
Change key no = 0
File size = 256
```

## 1.31. Change file settings (v) (DESFIRE LIGHT only)

Set file settings (communication mode and access rights).
In the configuration file set authentication key, file number and application key number.

```
Enter Read key number: 2
Enter Write key number: 3
Enter Read/Write key number: 3
Enter Change key number: 0
Choose new communication mode:
 1 - PLAIN.
 2 - MACKED.
 3 - ENCIPHERED.
1
File setting changed successfully
```

## 1.32. Delete transaction MAC file (w) (DESFIRE LIGHT only)

The transaction MAC file exists by default factory setting. This file must be deleted to regular use of value file and record file.

## 1.33. Check ECC signature (x) (DESFIRE EV2 and DESFIRE LIGHT)

If the card is not configured for Random ID, the command is freely available. There is no authentication required.
If the PICC is configured for Random ID, an authentication with any authentication key is required.



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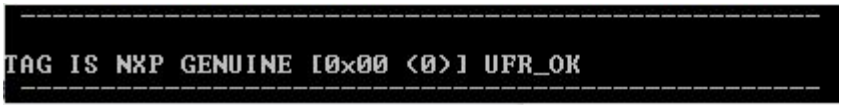


# Revision history

| Date | Version | Comment |
|---|---|---|
| 2020-10-15 | 1.7 | Check ECC signature(library version 5.0.45, firmware version 5.0.44) |
| 2020-04-10 | 1.6 | Transaction MAC support(library version 5.0.37, firmware version 5.0.38) |
| 2020-02-06 | 1.4 | Desfire Light support (library version 5.0.30, firmware version 5.0.32) |
| 2019-09-12 | 1.3 | SAM keys support |
| 2019-08-12 | 1.2 | DES, 2K3DES and 3K3DES keys support |



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